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TITLE: THE IMPACT OF SOLAR-ENERGY DEVELOPMENT: THE AGGREGATE IMPACT ON BASIC ECONOMIC OBJECTIVES

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THE IMPACT OF SOLAR ENERGY DEVELOPMENT: THE AGGREGATE IMPACT ON BASIC ECONOMIC OBJECTIVES

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1. INTRODUCTION

There is a generally accepted notion in this country that an increase in the use of solar energy is a desirable thing. This notion is based on the intuitively appealing position that when solar energy development increases dependence on foreign oil decreases, domestic reserves are conserved, the environment is protected and we are closer to energy independence. These conclusions are, in general, based on vaguely defined concepts of costs and benefits. While they do appeal to patriotic feelings, they do not reflect a systematic analysis of the economic impact of solar energy development and its affect on national economic goals.

Broad conclusions about solar energy are often based on a cursory analysis of a specific solar technology without consideration of more than a few areas of impact. It is clear that rational, intelligent decisions concerning the future development and application of solar energy technologies should be based on the careful identification, measurement and appropriate weighting of all of the impacts (both positive and negative) that may be associated with solar energy. In order to fully appreciate the importance of this approach and to place it in proper perspective it will be useful to define a set of national goals or objectives and thus set the stage for a discussion of the impact of solar energy development.

A listing of basic economic goals of this nation would include the following:
1) Full employment. Although there is no general agreement as to the precise definition of full employment (4 percent unemployment, 5-1/2 percent unemployment or something inbetween) full employment is generally accepted as an important social and economic objective.
2) A reasonable level of price stability. This does not necessarily mean no increase in the general level of prices, but does mean avoiding the double digit inflation of the late 70's.
3) Economic efficiency. This goal is synonymous with using all resources wisely and without waste, or in an 'optimal' manner. The economists' definition of efficiency is explained in section 2.
4) An equitable distribution of income. In the minds of many this is defined to mean the elimination of poverty, i.e., the guarantee of a minimum level of income for all individuals and families. This would presumably include adequate assistance programs for the aged, handicapped, and dependent children.
5) Economic growth. This goal implies that we are not willing to stand still but expect our standard of living to continue to rise over time.
6) Balance the Federal Budget. The Reagan Administration has concentrated considerable attention on our achievement of this goal and appears to give it high priority.
7) Maintaining a strong national defense. Although differences of opinion exist as to how the strength of our national defense is to be measured, it is clear that many place a high priority on this goal.

This is not intended as a complete list nor is the order intended to reflect priorities. However, in the discussion which follows we will treat this as a comprehensive listing of goals or objectives that may be impacted by solar energy. The point to be made is that in order to put passive solar development in proper perspective, its impact on each goal in a comprehensive list of goals must be addressed. Economics is a useful tool with which to assess certain consequences of solar energy development. It can assist in developing a better understanding of the specific consequences of solar energy development and application. It must then be left to others, the Congress, state legislatures and the "general public" to weigh the identified impacts in making and evaluating policy decisions.

2. GOVERNMENT POLICY AND SOLAR ENERGY DEVELOPMENT

It has been suggested that the adoption of solar technologies will return benefits to society as well as to the individual solar purchaser. Economists have argued that the private market provides less solar investment than is optimal because, while the individual bears the cost of installing solar, he receives only part of the benefits. If this is in fact an accurate indication of the costs and benefits associated with solar development, then government programs which encourage and/or aid solar investment are a reasonable response to this market failure. Determining the desirability of any one approach or various combinations of approaches requires a careful comparison of costs and benefits. The optimal solar program or set of programs is simply that which generates the greatest net benefit.

Government programs may promote solar development by altering consumers' and firms' behavior through a variety of market incentives. Although the ultimate impact of market incentives will be to increase the net benefits realized from solar application, it will be useful to group these incentives into two basic categories. Category one operates by increasing the benefits associated with the ownership of a solar energy system. For example, the deregulation of natural gas, a program that raises the price of conventional energy, increases the value of the stream of conventional fuel savings and thus increases benefits to be realized from the solar system.

It should be recognized that not all the benefits associated with solar applications are easily quantifiable in dollar terms. For example, it is difficult if not impossible to quantify the benefits realized from the increased living space that may result from attached sunspace. Similarly, it is difficult to measure the benefits realized from an enhanced self esteem associated with ownership of a solar system.

The second category of incentives operates by reducing the cost of the solar energy system. For example the current federal income tax credit lowers the initial cost to the consumer. Similarly, the business investment tax credit for energy conservation lowers the cost for commercial application. Grants to solar energy adopters or suppliers and sales tax exemption plans are other forms of direct and immediate cost reduction.

Recurring costs such as maintenance costs, loan payments and property taxes may also be impacted by category two solar incentives. Solar systems installed in new homes are generally financed with the mortgage while retrofit applications may be financed with a home improvement loan. A government low interest loan program may well have the effect of reducing these recurring mortgage/loan payments. Allowing tax credits for solar maintenance costs and exempting the value of the solar energy system from the taxable value of property, a common incentive provided by state and local governments, will effectively reduce two other common forms of recurring cost. All of these programs are properly classified as category two programs, i.e., programs that lower the initial cost of solar adoption.

Whatever incentive program or combination of programs is chosen, the policymaker must consider its impact on national goals. Some impacts are relatively easy to identify and quantify; the actual budget costs of a program, for example. Other impacts may be difficult to anticipate and quantify with any accuracy. In some cases even the direction of impact will be difficult to determine. However, this difficulty in quantifying certain impacts associated with solar incentives and the resulting solar applications does not reduce the importance of addressing each potential impact and, in some sense, aggregating these impacts. An attempt will be made in the following section to illustrate this approach by presenting a necessarily crude but comprehensive review of the impacts of passive solar development with regard to the broadly defined national objectives listed earlier.

3. THE IMPACT OF SOLAR ENERGY PROGRAMS

In this discussion, the impact of two alternative (or complementary) programs are presented in an effort to identify and contrast the probable impacts of the specific alternatives developed herein. The discussion will also attempt to distinguish between short-run (one to five years) and long-run (over five years) impacts expected to result from the installation of passive solar designs on existing single [illegible].

An effort has also been made to distinguish, where feasible, between the impacts associated with programs falling in each of the two categories defined above; a category one program designed to increase benefits and a category two program designed to reduce costs. In the analysis offered the category one program will be assumed to be "natural gas deregulation." The category two program will be assumed to be a combination of tax credit and low interest loan programs (initiated at the

TABLE 1

SUMMARY OF THE IMPACT OF MARKET INCENTIVES
TO PROMOTE SOLAR DEVELOPMENT

Impact	Short-Run		Long-Run	
Economic Objectives	Category one [increased benefits]	Category two [reduced costs]	Categor one [increased benefits]	Category two [reduced costs]
Employment	+	+	?	?
Price Stability	∓	∓	+	+
Economic Efficiency	+	+	+	+
Equitable Distribution of Income	?	?	?	?
Economic Growth	+	+	+	+
Balance the Federal Budget	∓	∓	?	?
Strong National Defense	+	+	?	?

\+ consistent

∓ consistent and contradictory

? unclear

state and/or federal level).

It should be obvious that the nature, scope and level of specific impacts will be dependent upon the absolute and relative amounts of the increase in benefits and reduction in costs resulting from the category one and category two programs, respectively.

We turn now to the analyses of solar program impacts on each of the seven basic economic goals defined in section 1. These impacts are summarized in Table 1. The pluses indicate that the impact of the program is expected to be consistent with or tend to promote that particular objective. A plus and minus suggests that impacts both consistent with and contradictory to the objective are expected to result from the solar energy programs. A question mark is recorded when the probable impact is unclear or insufficient information is provided to make a determination of the probable impact.

3.1 Full Employment

It is generally recognized that a program designed to promote the installation of passive solar designs on existing housing stock will have positive impact on employment in the construction industry. It is also obvious that this impact will be short-run in its duration, although it may be possible to design an incentive program that will spread the employment impact over a longer duration, e.g., ten years. In the absence of specific provisions designed to limit passive solar installation to certain geographic areas, or specific households defined by level or type of fuel used, it would be expected that category one or category two incentives would impact a broad segment of households throughout the nation.

The most immediate and direct employment impact will be in the construction industry. The increase in employment opportunities in the basic construction trades (foundation, framing, roofing, glazing, etc.) would be both direct and potentially significant for the industry. Given the labor-intensive character of this industry, the limited technical knowledge and skills required, and the limited barriers to the entry for new small business, it is expected that a significant number of new construction businesses may come into existence as a result of such a program.

Indirect or secondary employment effects

can also be expected to be positive and visible in local government offices dealing with building permits and in suppliers of basic materials necessary for construction of passive solar systems (dimension lumber, concrete block, cement, plastic and/or glass, etc.). As in the case of the direct employment impacts in the construction industry it is expected that these secondary employment effects will be short-run in duration.

If the positive short-run employment impacts were to coincide with a period in which the construction industry was seriously depressed (as is now the case) these impacts would be very welcome indeed.

To the extent that increased spending by government, developers and/or households associated with the solar incentive program is financed by borrowing there is a potential for increased upward pressure on interest rates. Any resulting "crowding out" effect that leads competing borrowers to delay planned investment will at least partially offset the short-run positive employment impact of an incentive program. It is most unlikely that the short-run positive employment impact could be completely nullified as a result of such a "crowding out" effect.

3.. Price Stability

The Consumer Price Index (CPI) is our traditional measure of what is happening to the cost of a specific market basket of goods. A body of literature has developed that discusses the inaccuracies involved in attempting to use the CPI as a measure of change in the cost-of-living. It is not necessary to review these deficiencies here; however, it is important to recognize that the impact of a passive solar incentive program on the cost-of-living will not be accurately or fully reflected in CPI figures.

More specifically, it is not clear that the incentive program will cause the price of conventional energy to decline or will retard future increases, but such a program can significantly reduce the cost of space heating for impacted households. The reduced cost of space heating can be expected to be a long-term impact benefiting the household year after year on a continuous basis.

Short-term inflationary pressure may develop if the incentive program happened to impact on the construction industry and on suppliers at a time when idle capacity was not present. Although a potential for some inflationary pressures associated with a solar incentive program is present, it is expected that the magnitude of the fuel bill saving would far exceed any short-term inflationary pressures that may arise.

3.3 Economic Efficiency

Market failure results when prices fail to accurately register social benefits and costs. For example, there is general agreement that the price of conventional energy is lower than its true social cost. This reflects such facts as: pollution costs are not borne by consumers alone but by society; average cost pricing by utilities has disguised the true cost of incremental energy consumption; and the special tax advantages provided oil and gas exploration and production also tend to distort conventional energy costs. These factors result in a cost of conventional energy as reflected in the market which is below its social cost. Solar energy appears to be less attractive as an alternative energy source when it must compete with underpriced energy (or subsidized) source. This is one type of market failure. Natural gas deregulation would tend to promote economic efficiency through price increases of natural gas. The price would then be closer to the true social cost.

Less than optimal solar investment can also result from the market's failure to provide public goods. A public good is one whose benefits are received by individuals other than the owner. For example, a television signal can be picked up by anyone with an antenna, including persons who do not bear the cost of sending that signal. Solar research and information exhibit characteristics of public goods. If one solar home builder were to pay for an advertising program extolling the virtues of solar energy, all builders could be expected to benefit from the resulting increase in demand. Because the individual builder does not share in the benefits accruing to his competitors (or to consumers) his personal benefit may be smaller than the program cost, thus resulting in less than the socially desirable level of information being supplied by the private sector of the economy (the solar construction industry . Category two programs might include elements of information dispersal which could alleviate this problem to some degree.

3.4 An Equitable Distribution of Income

The distributional impacts are an area of major concern in the evaluation of programs designed to promote solar energy development. Policies which promote a more equitable distribution of income are generally consistent with public preferences. The distributional impacts of specific solar programs will depend on the

basic elements of subsidization and/or cost absorption included in the program; some elements of a program (e.g., tax credits) may give a disproportionate benefit to high income classes while others (e.g., direct subsidies may be designed to benefit lower income households.

Programs that lower the cost of solar or raise the cost of conventional fuels are probably not consistent with income distribution goals. Expenditures for residential space-heating are regressive in that lower income households spend a greater percentage of their incomes on energy bills. An increase in the cost of fuel, while promoting the application of solar energy, would at the same time have its greatest relative impact on low income households; those households least able to respond by investing in solar energy systems.

Tax credits may similarly provide a greater potential advantage for high income households. As income and marginal tax rates increase, the advantage of solar investment over investments whose earnings are taxable, increases. Therefore, the feasibility and profitability of investment in solar energy systems tends to vary directly with the households' tax bracket. It should also be noted that tax credits can only be applied against a tax liability. Low income households with limited tax liabilities may not be in a position to realize the full value of the tax credit.

Solar incentive programs designed to benefit low income households would appear to be the most consistent with equity goals, but may not maximize the level of energy saving. This suggests the possibility of a conflict between solar incentive programs consistent with our concept of an equitable distribution of income and those incentives that would maximize energy savings, a concern of economic efficiency. This discussion indicates the importance of recognizing, quantifying and weighing the impact on income distribution of alternative solar incentive programs being considered.

3.5 Economic Growth

Economic growth is generally measured by examining changes in real GNP per capita over time. Increased levels of investment and increased efficiency in the allocation of resources would generally be expected to be consistent with a more rapid rate of economic growth.

For example, investment in solar energy systems by the residential sector will have a number of impacts consistent with, or tending to promote, economic growth. The freeing of conventional fuels for use in the industrial sectors of the economy, will eliminate the need to switch to less efficient sources of energy. Similarly, industries (including electric utilities) will not be forced to undertake nonproductive investment in the form of furnace modifications to burn alternative fuels and/or investment in pollution control equipment necessitated by fuel switching. Savings realized by households and industry may then be available for investment in more productive investment opportunities.

The impact of solar investment by the household sector on the gas and electric utility industries is of particular interest. The reduction in energy demand resulting from the solar energy application may postpone or in some cases eliminate the need for planned expansion of capacity. Such an impact will reduce, delay or eliminate costly investment in expanded capacity. Such a change in investment plans may have important repercussions on both the cost and availability of funds for other purposes as well as a significant effect on the utility bills of household and commercial customers who fail (or are unable) to adopt solar energy technology.

3.6 A Balanced Budget

In the current political climate the impact of the category one (natural gas deregulation) and category two (tax credit and low interest loans) programs on the federal budget is clearly a matter of concern.

The deregulation of natural gas will, at least in the short-run, contribute to increased government revenues. The revenues will result from increased gas royalties, increased income taxes paid by natural gas producers, company stockholders and private recipients of natural gas royalties, and increased severance taxes paid by natural gas producers.

A category two program which takes the form of a direct subsidy will, on the other hand, increase budget outlays while a subsidy in the form of tax credit will reduce tax receipts. In either case, the short-run, impact on the federal budget of such incentive programs appears to be negative.

Administrative costs associated with the category two program will also increase budgetary outlays. The level of this impact will, of course, depend upon the nature of the incentive program introduced. A tax credit or rebate program would be expected to require only minimal

adminstrative and monitoring costs. Educational programs or demonstration projects may require more extensive infrastructure.

The negative budgetary impact associated with a category two (subsidy or tax credit) will be at least partially offset by the taxes generated by the increased level of business activity in the construction industry.

The net impact of a solar incentive program will obviously depend upon the basic elements of that program and the level and the timing of the economy's response.

3.7 A Strong National Defense

There are several arguments that may be offered in support of the position that the development of solar energy is consistent with the nation's goal of a strong national defense. For example, it is suggested that the reduction in conventional fuel consumption associated with solar energy development will lessen this nation's dependence on foreign energy supplies and thereby strengthen our national security position.

Precisely how reduced dependence on foreign energy supplies strengthens the national defense is unclear. It may be argued that this reduced dependence on foreign energy sources strengthens our bargaining position in dealing with international crisis. Indeed, the impact may be more a matter of form than substance. That is, other nations may perceive the United States to be in a stronger posture because it is less dependent on foreign sources of energy resources, when in fact this is not a significant element in measuring the strength of our national defense in either absolute or relative terms.

It may also be argued that the reduction in domestic energy demand associated with the application of solar energy technology will enhance this nation's ability, in the short-run, to develop "strategic reserves." It is argued by some that these "strategic reserves" are important to our national defense. As a final example, it may be argued that increased tax revenues realized from natural gas deregulation (a category one incentive program) may provide funding for increased military expenditures.

As indicated in these comments the relationship of solar energy development to national defense is not a simple or direct one. Nevertheless, the nature and scope of the impact of solar energy on national defense is a matter to be considered in the examination of alternative solar energy incentive programs.

4. SUMMARY AND CONCLUSIONS

This paper has been concerned with the aggregate impact of solar energy incentive programs designed to promote the construction of solar energy retrofit systems. The discussion and analysis relating to the potential impact of such programs on seven national economic goals provides a clear indication of the extensive, diverse and complex nature of the aggregate impact.

For this reason the weighting of impacts and the final aggregation of impacts resulting in an evaluation of alternative programs must be left to th policymaker. With an appropriate level of understanding of the probable impact of alternative programs on the economic objectives of this nation the policymaker is in a position to select the program most consistent with what he or she perceives to be the priorities of American people.

While the exercise presented in this paper, does not provide all the information necessary to make a policy decision, it is valuable in and of itself. This value results from an enhanced ability to identify those objectives where impacts cannot be anticipated with any degree of certainty and to identify objectives where conflicting impacts or tradeoffs exist. More simply, the exercise illustrated here helps to identify those areas of impact where additional empirical investigation is clearly desirable.